

Exceptionally High-Speed Data Acquisition for TOF-MS with Chromatographs



- **2-GHz effective sampling rate** (0.5-ns sampling interval)*
- **>10 spectra/second** to disk . . . for >30 minutes
- **100 times higher data rate** than a time digitizer for:
 - **Better statistical accuracy (10X)**
 - **Lower detection limits (10X)**
- **End-of-Scan dead time <1 μ s** (<1% idle time)
- **Precision Enhancer[†]** transforms the 8-bit ADC into a 12-bit ADC . . . for 16 times greater dynamic range
- **Record lengths up to 262,000 data points** at 0.5, 1, or 2-ns sampling intervals for flight times up to 524 μ s
- **Sum up to 65,535 records** in each spectrum for improved signal-to-noise ratios
- **Real-time DSP data compression[‡]** reduces storage file size by a factor of 10
- **Complete with software** operating under Windows[®] 98/2000/XP/NT V4.0 with Service Pack 3 or later for control, data acquisition, and display

*U.S. Patent 6,094,627

† U.S. Patent 6,028,543

‡ U.S. Patent 5,995,989

A Powerful Solution for Chromatograph/TOF-MS Applications

The FASTFLIGHT Digital Signal Averager excels at delivering exceptionally high data acquisition rates . . . exactly what is needed for Electrospray Time-of-Flight Mass Spectrometry (TOF-MS), especially when the TOF-MS input is fed by the output of a chromatograph. Figure 1 is a simplified illustration of the typical application.

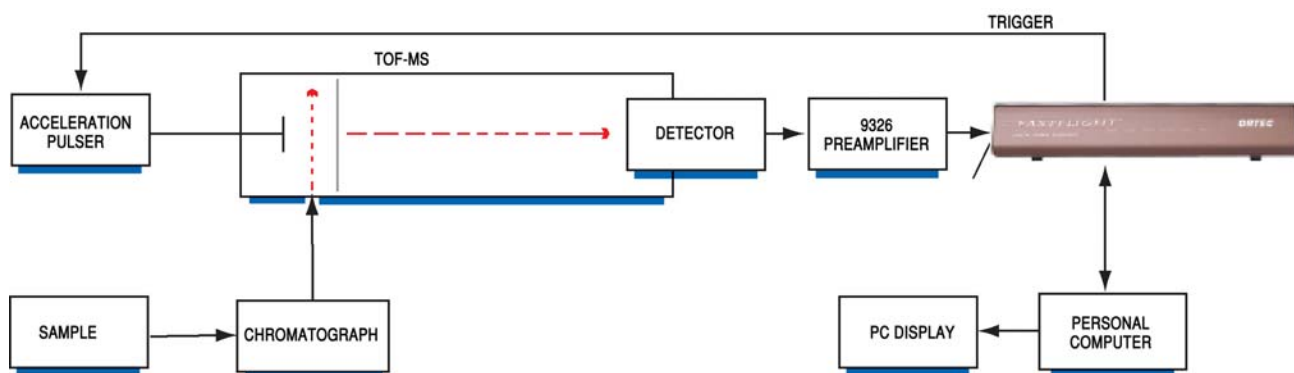


Figure 1. The FASTFLIGHT Digital Signal Averager Applied to Data Acquisition with an Electrospray TOF-MS Receiving the Output of a Chromatograph.

A sample is injected into a chromatograph and the output of the chromatograph is fed to the Electrospray ionization source at the input to the TOF-MS. In the TOF-MS a brief (circa 10 μs) acceleration pulse shoots the ionized molecules down the field-free drift tube. Lighter molecules are accelerated to a higher velocity and arrive at the detector sooner than the heavier molecules. The flight time from the acceleration region to the detector is proportional to $(m/z)^{1/2}$, where m is the mass of the molecule and z is the amount of charge on the ionized molecule.

When a packet of ions of a particular value of m/z arrives at the detector, the detector produces a narrow (circa 3 ns wide) analog output pulse whose amplitude is proportional to the number of ions in the packet. For each acceleration pulse numerous packets, each having a unique m/z value, are produced. The flight times for these packets typically range from a few microseconds for the lighter molecules to about 100 μs for the heaviest molecules.

For each acceleration pulse, the FASTFLIGHT digitizes the analog signal from the detector and adds that 100- μs digital record to the sum of the previous records. This process is repeated for a few hundred acceleration pulses to improve the signal-to-noise ratio by averaging. The time-of-flight (TOF) spectrum formed by summing the records is compressed by FASTFLIGHT and sent to the supporting computer for storage on a hard disk. Figure 2 is an example of such a spectrum.

Using a least-squares fitting program in the standard FASTFLIGHT software, the spectrum in Figure 2 is quickly calibrated and displayed in units of m/z , as shown in Figure 3.

FASTFLIGHT™

Digital Signal Averager

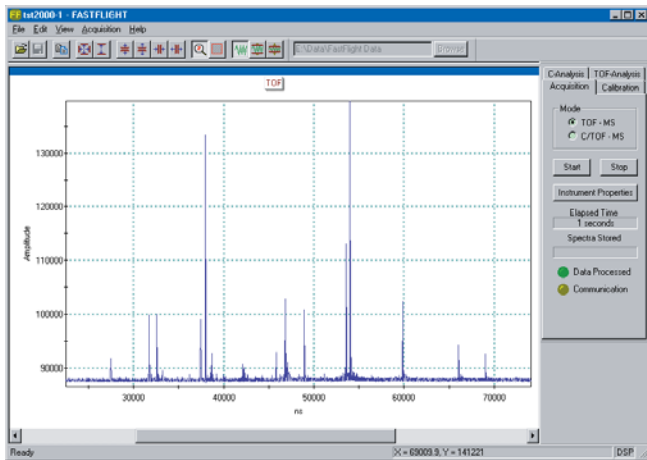


Figure 2. A Typical Time-of-Flight Spectrum Acquired by FASTFLIGHT from the System in Figure 1.

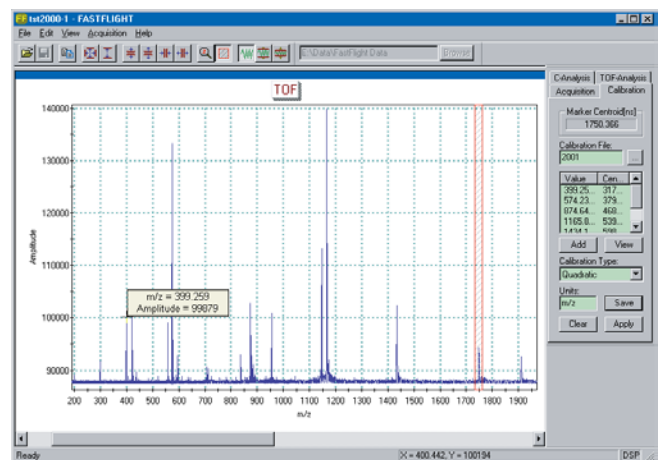


Figure 3. The TOF Spectrum of Figure 2 Mapped to Units of m/z.

Ultra-Fast Data Acquisition Is Essential

From start to finish, the chromatograph output spectrum typically spans 30 minutes, and consists of a series of peaks exhibiting widths of the order of a few seconds. Each peak represents the separation of a particular species of molecules. The task of the mass spectrometer is to identify the molecules in each chromatograph peak according to their mass spectra.

To resolve the information in the chromatograph peaks, the TOF-MS must collect and save a new TOF spectrum approximately every 0.1 seconds. This task demands data acquisition rates that are several orders of magnitude above what is feasible with a conventional digital oscilloscope. FASTFLIGHT meets this challenge with the following exceptional performance.

Typically, FASTFLIGHT sends a new spectrum to the computer every 0.1 seconds, and the PC stores the spectrum on hard disk. Each spectrum consists of the sum of 250 records. A record spans 99 μ s, with 198,000 data points providing samples of the detector signal voltage at 0.5-ns intervals. During the 30-minute chromatograph, 18,000 TOF spectra are streamed to disk. With 24 bits full scale on the summed signal amplitude, the uncompressed data flow is 5.9 megabytes/second, and the amount of uncompressed data generated in a 30-minute chromatograph is 11 gigabytes. Both the data rate and the amount of data are beyond the capacity of the hard disk. The Digital Signal Processor (DSP) in the FASTFLIGHT eliminates this bottleneck by compressing the data by a factor of 10 (typically). This brings the data rate and file size within the capacity of a hard disk.

During this high-speed data acquisition, the standard software supplied with FASTFLIGHT provides a live display of the growing chromatograph. At the same time, the TOF-MS spectrum for any point in the chromatograph can be displayed (Figure 4). Each data point in the chromatograph represents the sum of the areas of the peaks in the corresponding TOF-MS spectrum.

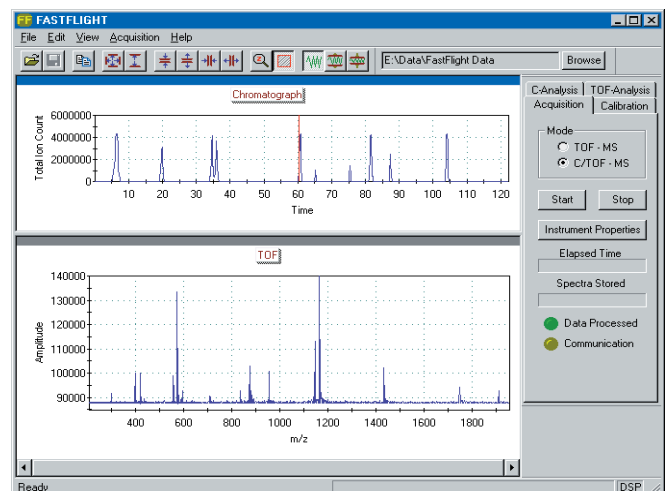


Figure 4. The Live Chromatograph and TOF-MS Display Provided by FASTFLIGHT During Data Acquisition.

100 Times Higher Ion Rates than a Time Digitizer

Compared to a time digitizer, FASTFLIGHT has negligible dead time. Time digitizers work in the single-ion timing and counting mode and suffer substantial dead time after each detected ion in a scan. This dead time limits the maximum data acquisition rate. FASTFLIGHT operates in the multi-ion mode and has no dead time during a scan. Consequently, FASTFLIGHT can accommodate ion rates that are more than 100 times higher than the rates tolerated by time digitizers. This means ten times better statistical accuracy and ten times lower detection limits in the chromatograph/TOF-MS application.

Continuous Data Acquisition with Negligible Idle Time

Figure 5 illustrates the FASTFLIGHT architecture that delivers exceptional functionality in the TOF-MS application. The Model 9326 Fast Preamplifier (Fig. 1) amplifies the signal from the detector to provide negative-polarity pulses with amplitudes in the range of 0 to -1 V for the analog input to the Digital Signal Averager (Fig. 5). The input signal is summed with the output of a 12-bit Digital-to-Analog Converter (DAC) to control the dc baseline for the measurement.

A highly-precise sampling clock causes the 8-bit Analog-to-Digital Converter (ADC) to sample and digitize the input signal at 2-ns intervals. This clock also synchronizes the addition of the sampled data to the Averager Memory. Within 1 μ s after the end of each record, the Trigger Control issues another Trigger Pulse to the TOF-MS, and the scan commences for the next record. Each new record is added to the sum of the previous records as the record is acquired. When the last record in a spectrum is being summed with the previous records, the sum is written into the Output Buffer Memory.

Memory. Within 1 μ s after completion of the final record in the spectrum, the Averager Memory is released to begin summing records for the next spectrum, while the previous spectrum is transferred to the computer. Throughout the data acquisition process the end-of-scan dead time typically causes <1% idle time.

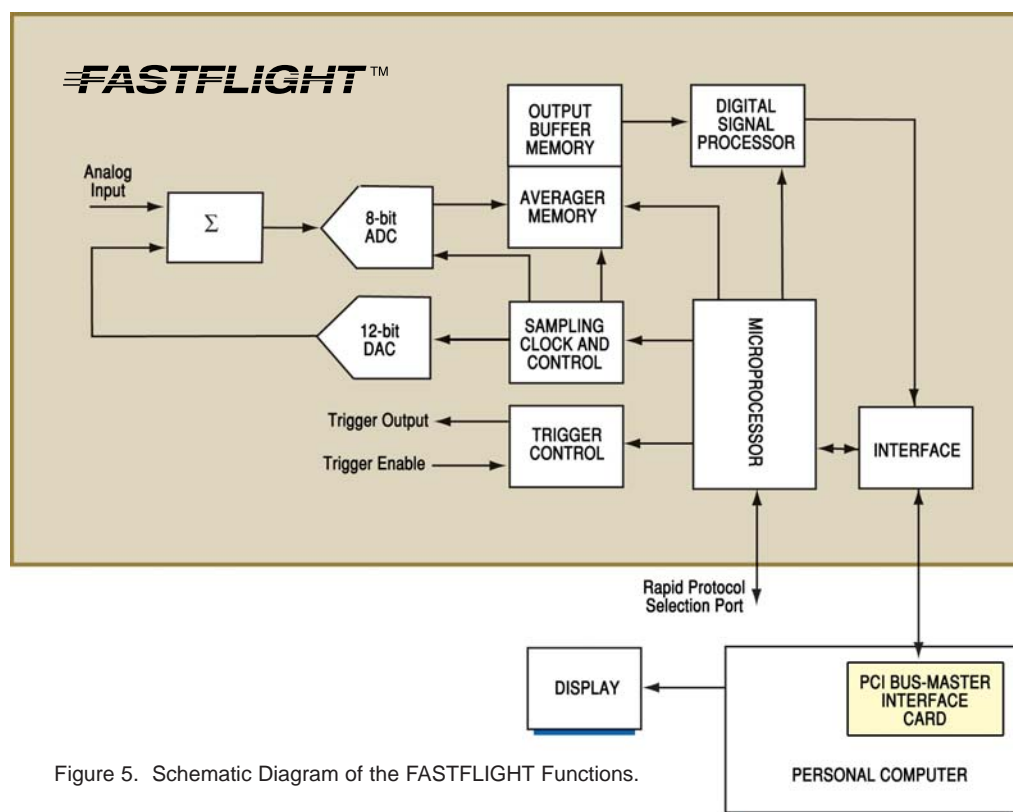


Figure 5. Schematic Diagram of the FASTFLIGHT Functions.

Automatically Adaptive Data Compression

The Digital Signal Processor (DSP) implements the optional data compression* as the data streams from the Output Buffer Memory to the computer. It employs a method that automatically adapts to changes in background levels and changes in the fluctuations superimposed on the background. Peaks that rise above the background fluctuations are sent to the computer, while most of the barren background regions are discarded. Background in the immediate neighborhood of a peak is forwarded with the peak to permit accurate background subtraction in the compressed spectrum. Every 200th background point is also preserved to yield a sketch of the background between peaks. Data compression ratios between 2 and 30 are possible, depending on the density of peaks in a spectrum. Compression by more than a factor of 10 is typical. This eliminates the data bottleneck at the hard disk.

High-Speed Data and Command Interfaces

From the DSP the data flows through a 25-megabyte-per-second (MB/s) serial link to a PCI-Bus interface in the supporting computer. The PCI-Bus-Master card and interconnecting cable are supplied with FASTFLIGHT. This link is also used to transfer commands and responses between the computer and the Digital Signal Averager.

A Rapid Protocol Selection Port provides direct access to the microprocessor in the FASTFLIGHT for those who wish to change data acquisition conditions during a chromatograph run. Typical use would be to alternate between the precursor-ion spectrum and the fragmented-ion spectrum during a chromatograph. Thus, both chromatographs are collected in a single run, and each can be displayed separately. FASTFLIGHT operating parameters can be switched in <1 ms between spectral acquisitions. Use of this port requires additional electronics designed to coordinate the corresponding parameters in the TOF-MS.

Precise Trigger Synchronization

The Trigger Output of the FASTFLIGHT is synchronized with the internal sampling clock, and must be used to trigger the acceleration pulse of the TOF-MS. For 2-ns sampling intervals this ensures that the repetitive input signal is sampled at exactly the same points on each scan.

To achieve 1-ns or 0.5-ns sampling intervals, FASTFLIGHT uses a trigger-offset technique.* For 1-ns sampling the first scan is taken with samples at 2-ns intervals. On the second scan, the delay between the trigger and the 2-ns clock is incremented by exactly 1 ns. The two scans are interlaced to form one record with 1-ns sampling intervals. For 0.5-ns sampling, the same method is used, except that four scans are interlaced to form one record. Each scan is offset by a 0.5-ns trigger delay relative to the previous scan. Thus, 0.5-ns sampling yields an “effective” 2-GHz sampling rate.

This technique is much more cost effective than the alternative “true” 2-GHz sampling. The latter method requires operating 4 digital signal averagers in parallel, with their 2-ns sampling clocks precisely synchronized, and the analog signal inputs successively delayed in steps of exactly 0.5 ns relative to the first digital signal averager. A thorough statistical analysis† shows that “effective” 2-GHz sampling achieves the same information rate as “true” 2-GHz sampling for the Electrospray TOF-MS application, but at a fraction of the cost.

*U.S. Patent 5,995,989.

*U.S. Patent 6,094,627.

†See the FASTFLIGHT instruction manual.

Precision Enhancer for 16 Times Greater Dynamic Range

FASTFLIGHT incorporates a Precision Enhancer* that transforms the 8-bit sampling ADC into a 12-bit ADC when averaging circa 256 or more records. Effectively, this increases the dynamic range for digitally resolvable voltage signals by a factor of 16.

Without the Precision Enhancer, the digital precision and accuracy of the 8-bit sampling ADC are limited by the width of one least significant bit (1 LSB) and by the variability of that width throughout the voltage span of the ADC. The variability of the width is commonly referred to as the differential nonlinearity. Figure 6 demonstrates the digital resolution and differential nonlinearity of the 8-bit ADC. A voltage that linearly ramps from 0 to -1 volts in 70 μ s was applied to the input of the Digital Signal Averager, and 8192 records were averaged. Figure 6 shows an expanded view around mid-scale. Each stair step corresponds to 1 LSB of the ADC. The variability in the width of the stair steps is caused by the differential nonlinearity.

In Figure 7, the Precision Enhancer has been turned on. Otherwise conditions are the same as in Figure 6. Note that the stair steps have essentially disappeared because the digital resolution has improved by a factor of 16, and so has the differential nonlinearity. The Precision Enhancer transforms the 8-bit ADC into a 12-bit ADC for a factor of 16 improvement in dynamic range. This permits accurate digital resolution of signal amplitudes less than 4 mV. It also improves the accuracy with which large signals are digitized.

*U.S. Patent 6,028,543.

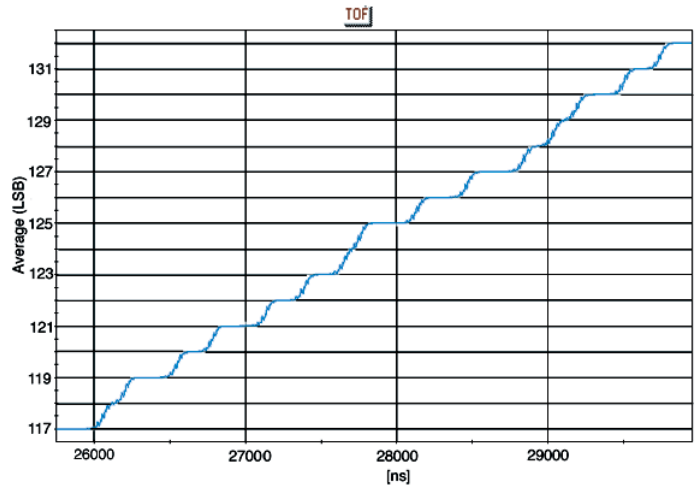


Figure 6. The Digital Resolution and Differential Nonlinearity of the 8-Bit ADC with the Precision Enhancer OFF.

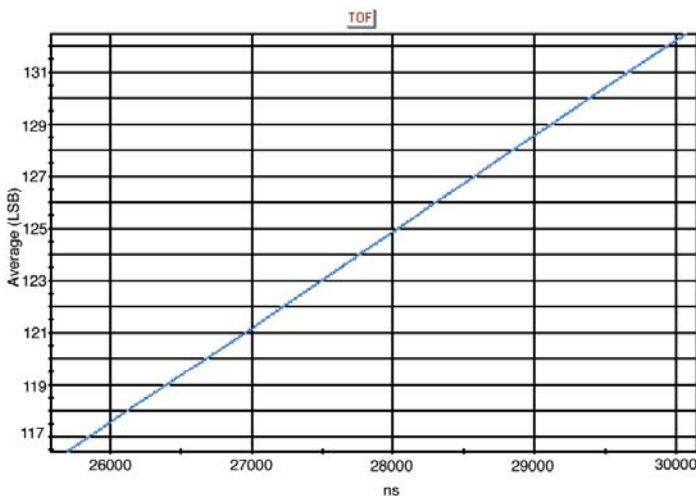


Figure 7. The Same Conditions as for Figure 6, But With the Precision Enhancer ON. Note that the digital resolution and differential nonlinearity improve by a factor of 16.

Complete with Operating Software

FASTFLIGHT includes a complete software package that provides control, data acquisition, and display functions. The software runs under Windows 98/2000/XP/NT V4.0 with Service Pack 3 or later for excellent reliability in high-speed data streaming. In addition to the routine control and display functions, the following exceptional features are offered in the software:

- Selection of the Chromatograph/TOF-MS mode, or the TOF-MS Only mode
- Pre-selection of up to 8 sets of operating conditions (protocols)
- Post-acquisition summing and averaging TOF-MS spectra across a selected region of a chromatograph peak
- Least squares fitting of a linear, quadratic, or cubic calibration curve to multiple data points to convert the display to units of m/z
- 3-point and 5-point data smoothing
- Mouse-click readout of the coordinates of any point
- Computation of gross or net peak areas and peak centroids
- Comparison of multiple spectra
- Display scale adjustments and zooming
- Copy the viewed graph to the clipboard and print or paste into another document

For those who wish to write their own software to control the TOF-MS in concert with FASTFLIGHT, the standard software is provided as three major objects: the Instrument Control Server, the Graphics Object, and the Client Application (see Specifications). A new client application can be written in a variety of programming languages to suit the situation. The Instrument Control Server and the Graphics Object can be called from the new client application via standard call formats. The Instrument Control Server and the Graphics Object painlessly take care of all the complicated control and display functions.

Supporting Computer

FASTFLIGHT requires a supporting computer. Any IBM®-compatible PC meeting or exceeding the following specifications will suffice. Choosing a PC with higher speed and capacity will improve performance.

- Windows 98/2000/XP/NT V4.0 with Service Pack 3 or later
- 200-MHz Pentium® microprocessor
- A minimum of 64 MB of RAM
- For the Chromatograph/TOF-MS mode, a second hard drive with at least 4 GB of free space
- CD drive
- VGA display
- An expansion slot for the PCI-Bus-Master Interface Card

Specifications*

Hardware

Model 9326 Fast Preamp

PERFORMANCE

Input Noise <100 μ V rms.

Output Rise Time <1 ns.

Low Frequency Roll-off <10 kHz.

Gain Selectable by board jumpers for 5, 10, or 20 V/V. The overall gain is non-inverting.

Operable Temperature Range 0–50°C.

INPUTS

Analog Input Front-panel BNC connector accepts negative-polarity analog signals in the range of 0 to –200 mV. Input impedance: 50 Ω ac, <1000 Ω dc to ground. Diode clamps provide protection against overload to \pm 2 V dc, or \pm 10 V for a 50-ns-wide pulse at a duty cycle of <1%.

OUTPUTS

Analog Output Rear-panel BNC connector provides a negative-polarity output pulse for the FASTFLIGHT analog input. Linear range is nominally +0.25 V to –1 V on a 50- Ω load. AC-coupled and short-circuit protected.



ELECTRICAL AND MECHANICAL

Power Requirements +12 V dc at 100 mA is supplied from the FASTFLIGHT through a 3-m (9.8-ft) long power cord. Mating connectors on the ends of the power cord are ORTEC-standard, 9-pin D, preamplifier power connectors.

Weight

Net 0.39 kg (0.85 lb).

Shipping 1.3 kg (2.9 lb).

Package and Dimensions Compact preamplifier box: 8.6 cm W x 13.3 cm D x 3.0 cm H (3.4 in. W x 5.3 in. D x 1.2 in. H).

FASTFLIGHT Digital Signal Averager

PERFORMANCE

Amplitude Digitizing Resolution 8-bit ADC nominally spans 1 V.

Precision Enhancer Extends the limiting ADC resolution to 12 bits (for input noise <4 mV) when circa 256 or more records are averaged.[†] Can be turned on or off.

Differential and Integral Nonlinearity (DNL and INL)

Measured from 5% to 95% of full scale using a 1-V, 70- μ s ramp with the Precision Enhancer on.

DNL Within \pm 0.15 LSB referred to the 8-bit ADC.

INL Within \pm 0.4% of full scale.

Bandwidth DC-coupled; rise time <1 ns.

Equivalent Input Noise

Uncorrelated with the Trigger <2 mV rms.

Correlated with the Trigger <0.2 mV rms.

Analog DC Offset (Vertical Offset) Computer adjustable from +0.4 V to –0.4 V with 0.25-mV resolution.

Sampling Intervals Computer selection of 0.5, 1, or 2 ns.

Record Length Computer selectable from 512 to 262,000 points in steps of 16 ns. The time spans for the minimum and maximum number of points in the record are:

Sampling Interval	Time Span per Record	
	Minimum	Maximum
0.5 ns	0.256 μ s	131.0 μ s
1.0 ns	0.512 μ s	262.0 μ s
2.0 ns	1.024 μ s	524.0 μ s

Scans per Record A complete record is formed by interlacing sequential scans, each offset from the previous scan by one sampling interval.[‡]

Sampling Interval	Number of Scans in a Complete Record
0.5 ns	4
1.0 ns	2
2.0 ns	1

[†]U.S. Patent 6,028,543

[‡]U.S. Patent 6,094,627

*Specifications subject to change without notice.

FASTFLIGHT™

Digital Signal Averager

Data Acquisition Delay (Time Offset) Computer selectable digital delay after trigger from 0 to 1048.56 μ s in 16-ns steps. The record starts after the selected delay.

End-of-Scan Dead Time Minimum time between the end-of-scan and generation of the next Trigger Output is selectable from 0.544 to 8.544 μ s in 32-ns steps. Jitter: 32 ns.

Sampling Clock

Frequency and Accuracy 500 MHz \pm 100 ppm.
Temperature Sensitivity Within \pm 10 ppm/ $^{\circ}$ C.

Trigger-to-Sampling-Clock Synchronization

Jitter <50 ps FWHM.
Systematic Error in Interlacing Offset Within \pm 20 ps over 0–50 $^{\circ}$ C; typically within \pm 5 ps at room temperature (22 $^{\circ}$ C).

Operating Temperature Range 0 to 50 $^{\circ}$ C.

Averaging Method Linear summation of sequential records.

Records per Spectrum The number of records summed for the average is selectable from 1 to 65,535.

Averager Memory Record lengths up to 262,000 words with 24 bits per word for summing successive records to form a spectrum. Buffered to allow computer readout while acquiring the next spectrum. End-of-spectrum dead time is identical to end-of-scan dead time.

Maximum Acquisition Time The number of TOF-MS spectra acquired can be limited by presetting the maximum time. Selectable in 1-s increments from 1 second to 65,535 seconds (\approx 18 hr), or disabled.

Spectra per Chromatograph The number of sequential spectra acquired can be limited by presetting a value from 1 to 18,000, or disabled.

DSP Data Compression As spectra are acquired, they are streamed through a Digital Signal Processor (DSP) for optional data compression before transfer to the supporting computer. Data compression is achieved by an adaptive method* that recognizes peaks, preserves data in the neighborhood of peaks, and discards most of the background data. Data compression ratios range from 2:1 up to 30:1, depending on the number of peaks in the spectrum and the desired detection sensitivity. Sufficient background points are preserved on either side of a peak to permit background subtraction from the

compressed spectrum. A sensitivity control is provided to adjust between the extremes of a) discarding all background at the expense of not detecting small peaks vs. b) preserving small peaks at the expense of less background rejection. In regions of extended background, typically every 200th data point is preserved to provide a sketch of the background shape in the compressed spectrum.

Maximum Spectra Transfer Rate With data compression ratios in excess of 2:1, FASTFLIGHT can write at least 10 full-size spectra per second to an 8-GB hard disk in a 266-MHz Pentium II PC and sustain that rate for 30 minutes. Proportionately higher rates can be achieved with shorter spectra lengths and with spectra that yield higher compression ratios.

Total-Ion Chromatograph The DSP computes the sum of the areas above background for all peaks in each spectrum, and passes that number to the computer via the spectrum header. This sum is used to plot the Total-Ion Chromatograph on the fly as TOF-MS data is acquired from an LC, GC, or CE (vs. retention time).

Time Stamp Each TOF-MS spectrum contains a time stamp in its header that defines the time at which the spectrum was acquired (2.5 ms resolution). This is used for plotting the chromatograph spectrum.

CONTROLS AND INDICATORS

Power Rear-panel switch turns ac power on/off. Front-panel LED indicates power on.

Trigger Front-panel LED flashes on each trigger pulse.

Acquire Front-panel LED indicates when computer has enabled the digitizer to process trigger pulses.

Readout Front-panel LED indicates when the data in the averager memory is being transferred to the associated computer.

Controller Front-panel LED indicates when the digitizer is making programmed changes in its operating parameters.

Over Range Front-panel LED flashes when the pulse amplitude at the analog input exceeds the maximum that the ADC can encode.

*U.S. Patents 5,995,989.



INPUTS AND OUTPUTS

All inputs/outputs reside on the rear panel.

Analog Input BNC connector accepts analog signals for digitization in the range of +0.4 V to -1.4 V. Nominally, a negative 1-V pulse amplitude yields a full scale, 8-bit analog-to-digital conversion. Input impedance is 50 Ω , dc-coupled. Protected to ± 2 V dc, or ± 10 V for a 50-ns-wide pulse at a duty cycle <1%. Input bandwidth limits rise time to ≈ 0.8 ns. Peaks in the TOF-MS spectrum have negative polarity at the DSA input, but are converted to a positive polarity when displayed on the computer screen.

Trigger Enable Input BNC connector accepts a TTL logic pulse to enable or disable the Trigger Output. Computer-selectable assignment of the "enable" condition to either the high or the low TTL voltage state. Holding the Trigger Enable Input in the "disabled" state prevents triggering. Input impedance selectable by a PWB jumper for 1-k Ω pull-up to +5 V or 50 Ω to ground. Minimum pulse width is 50 ns.

Trigger Output BNC connector supplies a trigger pulse synchronized with the sampling clock to achieve minimum sampling jitter, and to implement the interlacing of scans with offsets of 0, 0.5, 1, and 1.5 ns. Delay after Trigger Enable Input is <200 ns, with a variability of 34 ns. Used for triggering the ion extraction on a time-of-flight mass spectrometer, or for stimulating the process to be recorded in other applications. The TTL output pulse transitions from the low- to high-voltage state, remains in the high-voltage state for the selected trigger width, and returns to the quiescent, low-voltage state. Both rising and falling edges are synchronized with the sampling clock. Either edge can be used to trigger an external device. Trigger width is selectable from 64 to 8,192 ns in 32-ns steps. The output can drive a 50- Ω load, and is short-circuit protected.

Busy Output BNC connector provides a high TTL voltage when the digitizer has accepted a Trigger Enable Input and started a scan. BUSY returns to the low-voltage state at the end of each scan when the digitizer can process another trigger. BUSY is also held high whenever the digitizer is not able to respond to a Trigger Enable Input.

Start Output BNC connector provides a high TTL voltage when the Start software button is active, and a low TTL voltage when the Stop software button is active.

Abort Input BNC connector accepts a high TTL voltage to terminate a spectrum acquisition under the current protocol number. Minimum duration of the Abort signal in the high state is 50 ns. Input impedance is 1 k Ω to ground. Data acquisition is terminated by the Abort signal during the current scan.

Preamplifier Power Female, 9-pin D connector provides the dc power for the preamplifier. Pin assignments are +12 V on pin 4, -15 V on pin 9, and ground on pins 1 and 2.

Rapid Protocol Selection Rear-panel, board-mounted, male, 9-pin, D connector. (For signal definitions see the FASTFLIGHT manual.) This port permits the TOF-MS hardware to select the Digital Signal Averager (DSA) operating protocol in <1 ms, a

speed that is not viable through the normal PC interface to the DSA. This feature is used during a chromatography/TOF-MS acquisition to change the TOF-MS operating parameters as TOF spectra are acquired across a peak in the chromatograph. Typical use would be to alternate the TOF-MS between a) the fragmentation mode, and b) the precursor-ion mode. This permits the user to collect all varieties of molecular analysis during a single chromatographic run. In the DSA, the protocol is defined by the settings for the following items:

Protocol Parameters in DSA

- Protocol number (0 through 7)
- Sampling interval (ns)
- Record length
- Time offset (data acquisition delay after trigger)
- Vertical Offset (analog input dc offset in volts)
- Number of records per spectrum
- Precision Enhancer on/off
- End-of-scan dead time
- Data compression on/off
 - Minimum peak detection threshold
 - Auto-Noise Threshold on/off
 - Peak sensitivity factor
 - Adjacent Background
 - Background sampling interval
 - Minimum peak width
 - Maximum peak width
 - Ringing protection

The protocol number is stored in the header of each TOF spectrum. The Chromatograph Spectrum Display decodes the protocol number to display the chromatogram for the selected protocol number. The operator can choose any protocol number for live display at any time during acquisition of the chromatogram.

Computer (High-Speed Computer Interface) A rear-panel, female, RJ-45 connector (T568) accepts the 25 MB/s Serial Link with a PC for data transfer and control signals. A Category 5 Shielded Twisted Pair (STP5) cable connects the DSA via 4 twisted pairs to the PCI-Bus interface card in the PC. Maximum data rate to hard disk is 3 to 5 MB/s (depending on computer speed).

RS-232-C Port A male, 9-pin D connector provides access to all commands through a standard RS-232-C port for debugging purposes.

ELECTRICAL AND MECHANICAL

Power Requirements 90–264 V ac, 47–63 Hz, 100 W, 150 VA.

Weight

Net 5.7 kg (12.5 lb) including interface board and cable.
Shipping 8.2 kg (18.0 lb).

Package and Dimensions Bench-top case, 42.7 cm W x 39.6 cm D x 8.1 cm H (16.8 in. W x 15.6 in. D x 3.2 in. H). Cooling fans near the front of the left side panel and the rear of the right side panel require unrestricted air flow.

Software

General

ARCHITECTURE

The software provided with the FASTFLIGHT hardware comprises three main components: 1) the Instrument Control Server (ICS) Object, 2) the Graphing Object (GSX), and 3) the Client (main) Application.

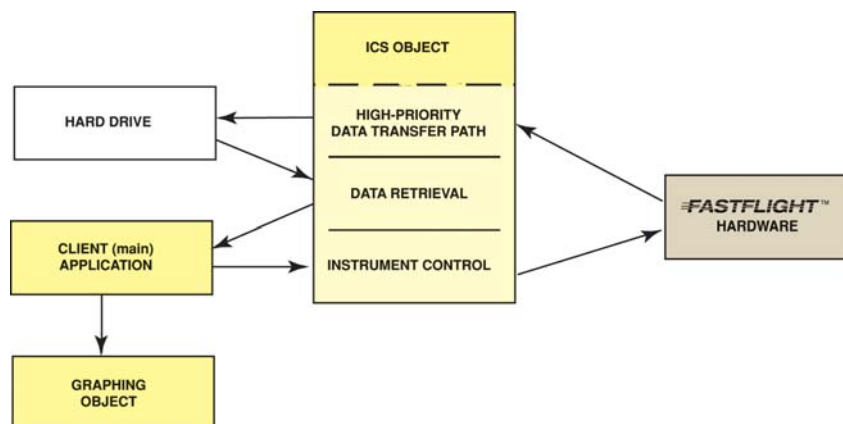
The Instrument Control Server (ICS) Object

is a Local-Process (.EXE) Automation Server that encapsulates the instrument control and data transfer. It provides an Automation interface that allows any Client software to control it. This means that the interface to the Server Object is the same no matter who writes the Client Application software and what programming language they employ. It also simplifies the Client Application programming, because all the complicated details of controlling the hardware and transferring data are simplified by the Server. Data is returned to the Client software from the Server in a "Safe Array" (in a raw data format). Instrument control is implemented using the standard "Get" and "Set" property format.

The Graphing (GSX) Object is a separate In-Process ActiveX (.OCX) Control that incorporates all the graphing methods. It provides a standard interface for any Client software to use for the purpose of displaying the data in graphical form.

The **Client (main) Application** supplied with the FASTFLIGHT provides all the operating and display features described in this brochure. It is a 32-bit application running under Windows NT V4.0 (Service Pack 3 or later) with Year-2000+ compatibility.

Programmer's Toolkit Those who wish to write their own Client Application programs can easily do so by utilizing the Server Object and the Graphing Object. These two Object programs take care of the complicated details involved in data acquisition, control, and display; and provide the applications programmer with a simple implementation. The toolkit includes the Automation Interface and a type library. The Server Object is compatible with National Instruments® LabVIEW™.



Standard Client Application Software

Software Controls Includes the control panels necessary to implement the hardware features listed above. See the FASTFLIGHT manual for full details.

Chromatograph Spectrum Display Provides a live display of the spectrum from the column source vs. retention time as the data is collected. Derived from the total ions (total peak area above background) in each TOF-MS spectrum (see Total Spectrum Sum). The user can select the chromatograph spectrum from any of 8 protocol numbers for display at any time during data acquisition.

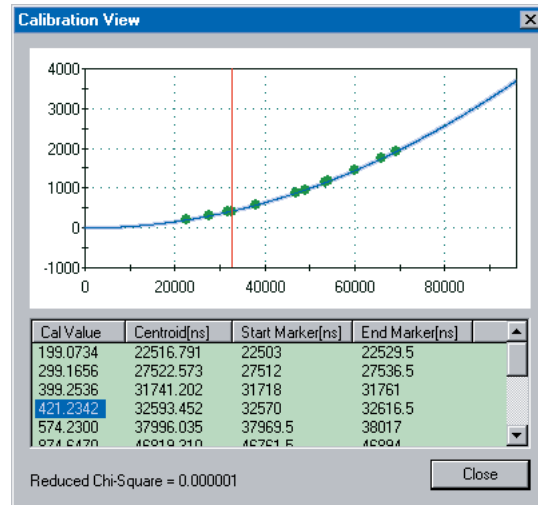
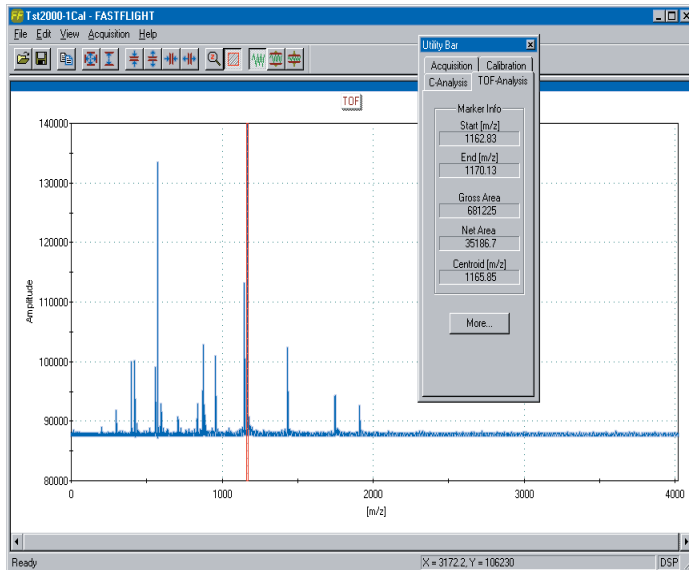
TOF-MS Spectrum Display Permits display of a TOF-MS spectrum that has already been acquired, without interruption of further data acquisition. It is possible to switch back and forth between the live chromatograph display and the TOF-MS spectrum display. A mode is also available for collecting a single TOF-MS spectrum without an associated chromatograph.

Time vs. Calibrated Units For the TOF-MS spectrum, the software provides a quick toggle selection of either the basic time units or the calibrated units (typically m/z or Daltons) for the horizontal scale.

Data Storage The standard software streams the data for storage onto a hard disk in the supporting computer. The programmer's toolkit enables custom solutions to be implemented for other storage media.

FASTFLIGHT™

Digital Signal Averager



Viewing the Quality of the Calibration Curve.

Ordering Information

To order, specify:

Model	Description
FASTFLIGHT	Digital Signal Averager (includes software, PCI-Bus Interface Card, and Interface Cable)
9326	Fast Preamplifier (includes power cable)
Optional RG-58A/U 50-Ω Cables with BNC Connectors	
C-25-1	30 cm, 1-ft length
C-25-2	61 cm, 2-ft length
C-25-4	1.2 m, 4-ft length
C-25-8	2.4 m, 8-ft length

Specifications subject to change
042604

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